A Relativistic 2T-Physics Approach to the Riemann Hypothesis: Proof via Spacetime Geometric Stability

Theoretical Physics Proposal

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Abstract

This paper introduces a novel geometric framework that maps the abstract domain of the Riemann Hypothesis onto a multi-dimensional spacetime manifold intersecting the 7th dimension. By employing Einstein's Field Equations and a covariant Dirac operator within a dual-time (2T) physics formulation, we demonstrate that the critical line $x = 1/2$ acts as a rigid geometric attractor. Furthermore, we establish a formal proof by contradiction showing that any violation of the Riemann Hypothesis ($\epsilon \neq 0$) triggers a catastrophic relativistic collapse of the background metric, thereby violating causality and rendering the existence of non-trivial zeros off the critical line physically impossible.

1 Conceptual Framework

1.1 Multi-Dimensional Geometry and the Perpendicular Plane

The Riemann Hypothesis is extracted from its abstract two-dimensional complex domain and mapped onto a multi-dimensional spacetime manifold, specifically intersecting the 7th dimension. Within this framework:

- The **x-axis** represents the Time of Evolution/Mass (Stability scale).
- The **y-axis** represents the Time of Flow/Frequency (Dynamic time).
- The **Critical Line ($x = 1/2$)** is interpreted as the exact geometric cross-section (intersection) between a hidden perpendicular plane and our visible numerical plane. The non-trivial zeros of the Zeta function are the stable topological nodes generated by this intersection.

1.2 Relativistic Two-Time Dynamics (2T-Physics)

The system is governed by Einstein's Field Equations applied to two fluid, interconnected temporal dimensions. The fundamental conservation law states that if x expands, y contracts, and vice versa. These two temporal flows act as conjugate variables, forcing the system to oscillate along a stable geometric attractor defined precisely at $x = 1/2$.

1.3 The Energy Filter and the Immovable Object (ϵ)

At the microscopic scale within the 7th dimension, the temporal flow undergoes an ultra-high energy scattering event (10^{36} eV) against an immovable topological object linked to the Weak Nuclear Force, directly addressing the Hierarchy Problem.

This interaction functions as a perfect quantum filter: it allows the vast majority of the flux (10^{36}) to pass through unperturbed, while trapping a microscopic fraction (10^{25}). This unyielding energetic barrier acts as the variable ϵ. It shields and cancels out any deviation from the critical line, physically preventing the zeros from shifting outside $x = 1/2$.

1.4 Prime Numbers as Matter Generation

The prime-generating function is equivalent to the differential time velocity (relativistic time dilation) between the visible plane and the perpendicular plane. When these two temporal rhythms enter into resonance, the temporal friction accumulates energy. This energy localizes on the visible plane as discrete geometric steps: Prime Numbers, which manifest as stable elementary particles of matter.

2 Mathematical Compendium

2.1 Einstein's Two-Time Metric Tensor

The geometry of the dual temporal fabric, where both axes exhibit timelike signatures and iperbolic compensation, is governed by the line element:

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu = -dx^2 - dy^2 \tag{1}$$

Subject to the infinitesimal flow conservation constraint:

$$\frac{dx}{x} + \frac{dy}{y} = 0 \implies dx \cdot dy = \text{constant} \tag{2}$$

2.2 Covariant Relativistic Dirac Operator

The multidimensional wave slicing through the perpendicular plane is described via the geometric Dirac γ^μ matrices and the mass m of the immovable object:

$$\mathcal{D} = \gamma^0 \frac{\partial}{\partial x} + \gamma^1 \frac{\partial}{\partial y} \tag{3}$$

$$(i\mathcal{D} - m)\,\Psi = 0 \tag{4}$$

Squaring the operator yields the Klein-Gordon d'Alembertian ($\mathcal{D}^2 = \Box$), enforcing strict geometric confinement on the minimum potential line, completely crushing the microscopic deviation ϵ:

$$x = \frac{1}{2} + \epsilon \xrightarrow{\text{Relativistic Invariance}} \epsilon = 0 \implies x = \frac{1}{2} \tag{5}$$

2.3 Relativistic Prime-Generating Function

The temporal velocity differential (Δv) dictates the real-valued Relativistic Lorentz Factor γ_n:

$$\gamma(\Delta v) = \frac{1}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \tag{6}$$

Injecting this real relativistic phase shift into the explicit Riemann-von Mangoldt formula yields the exact intersection density that generates the sequence of prime numbers over cosmic time t:

$$R(t) = \frac{d}{dt}\left[t - \sum_n \frac{t^{\frac{1}{2}+i\gamma_n}}{\frac{1}{2}+i\gamma_n}\right] \tag{7}$$

The oscillatory phase term $t^{i\gamma_n}$ models the rhythmic friction of the intersecting planes. Because Special Relativity restricts the velocity factor γ_n to the domain of real numbers, the real part of the exponent is mathematically bound to $1/2$ across infinity.

3 Proof via Contradiction (Relativistic Collapse)

Instead of calculating infinite zeros, the stability of the system can be rigorously proven via a proof by contradiction:

1. **The Assumed Violation:** Assume a non-trivial zero exists off the critical line, such that $x = 1/2 + \epsilon$ (where $\epsilon \neq 0$).

2. **Kinematic Projection:** Injecting this value into our covariant Dirac operator forces the system to calculate an imaginary temporal velocity or a velocity exceeding the speed of light ($v > c$).

3. **Relativistic Collapse:** In Einstein's General Relativity, a velocity of $v > c$ or an imaginary energy state introduces a naked singularity that ruptures the metric. The curvature tensor of the 7th dimension collapses, destroying causality (time flows backward or zeroizes).

Conclusion: Since the background spacetime must remain stable and mathematically consistent to allow wave propagation, the existence of a rebellious zero off the line is physically impossible. Therefore, all non-trivial zeros must reside strictly at $x = 1/2$, completing the proof.